

## Quantum Calorimeters Based on HgCdTe Alloys, Phase I

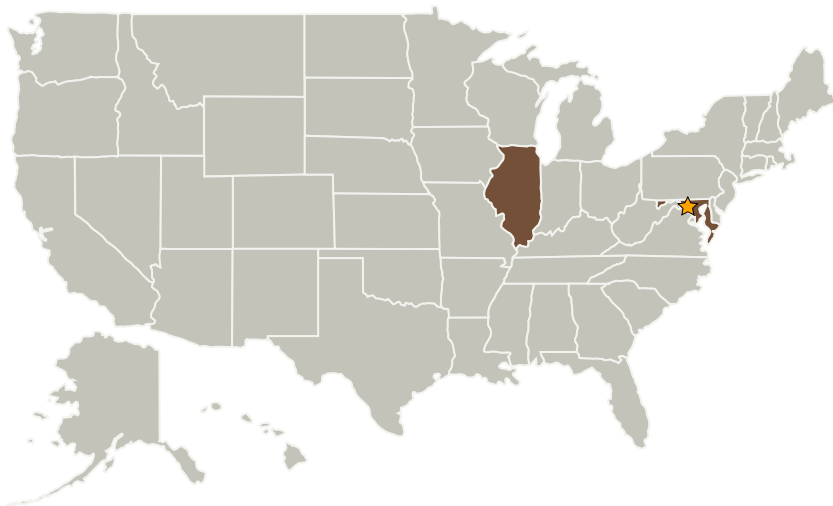
Completed Technology Project (2007 - 2007)



## Project Introduction

NASA's next generation of x-ray observation missions require x-ray calorimeters with superior energy resolution. Semimetallic HgTe has already proven itself as an excellent soft x-ray absorber material due to its low heat capacity. The alloy  $\text{Hg}_{0.834}\text{Cd}_{0.166}\text{Te}$  is predicted to also have zero energy gap at  $T=0$  K and a heat capacity even less than that of HgTe due to: (i) a greater Debye temperature (resulting in a lower lattice heat capacity), and (ii) a smaller electron effective mass (resulting in a lower electronic heat capacity). Thus  $\text{Hg}_{0.834}\text{Cd}_{0.166}\text{Te}$ -based microcalorimeter arrays are expected to have an energy resolution superior to that of HgTe-based ones. We propose the growth of single crystal  $\text{Hg}_{0.834}\text{Cd}_{0.166}\text{Te}$  layers by molecular beam epitaxy on Si substrates. Mercury vacancies will be filled after growth to reduce the possibility of them acting as acceptors and introducing a significant electronic heat capacity. The  $\text{Hg}_{0.834}\text{Cd}_{0.166}\text{Te}$  layers will be characterized by x-ray diffraction to assess their structural quality and crystallinity, FTIR mapping to confirm the uniformity of their energy gaps and alloy compositions, Hall measurements to assess their electrical transport properties, etch pit density counts to determine dislocation densities, transmission electron microscopy to determine microscopic structural information, and heat capacity measurements at mK temperatures to test their promise as high energy resolution quantum calorimeters.

## Primary U.S. Work Locations and Key Partners



Quantum Calorimeters Based on HgCdTe Alloys, Phase I

## Table of Contents

Project Introduction	1
Primary U.S. Work Locations and Key Partners	1
Organizational Responsibility	1
Project Management	2
Technology Areas	2

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Center / Facility:**

Goddard Space Flight Center (GSFC)

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Quantum Calorimeters Based on HgCdTe Alloys, Phase I



Completed Technology Project (2007 - 2007)

Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland
EPIR Technologies, Inc.	Supporting Organization	Industry Small Disadvantaged Business (SDB)	Bolingbrook, Illinois

## Primary U.S. Work Locations

Illinois	Maryland
----------	----------

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

Carlos Torrez

## Technology Areas

**Primary:**

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - └ TX12.1 Materials
    - └ TX12.1.6 Materials for Electrical Power Generation, Energy Storage, Power Distribution and Electrical Machines